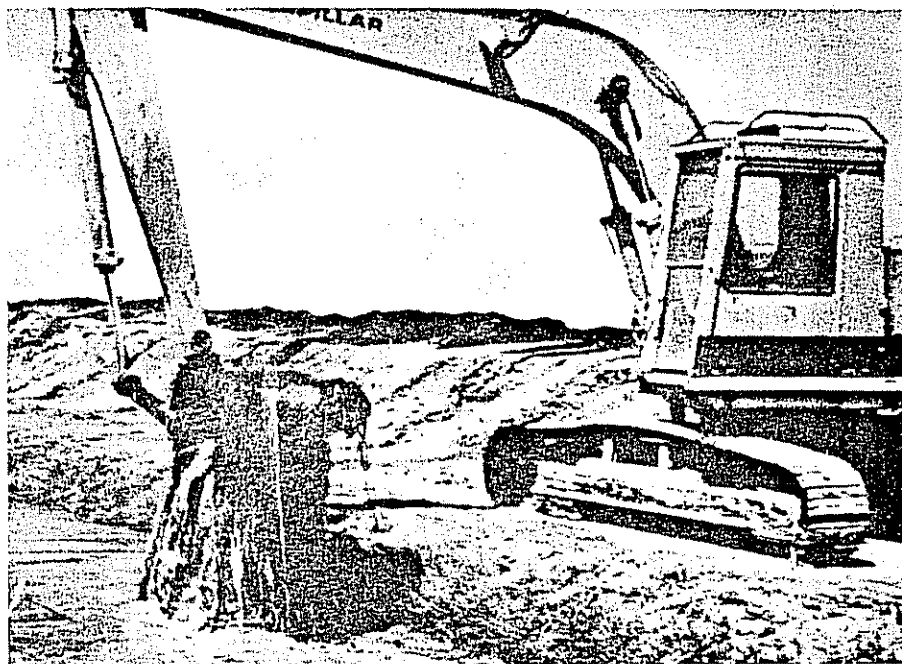




A DISTRICT DRAIN BEING CLEANED.

EXHIBIT III.10



HYDRILLA WAS FIRST DISCOVERED IN THE DISTRICT'S SYSTEM IN 1977. A TEAM OF BIOLOGICAL SCIENTISTS WAS HIRED TO COMBAT THIS AQUATIC WEED, WHICH THREATENS TO CHOK OFF THE FLOW OF WATER IN ITS CANALS.

EXHIBIT III.11

TABLE III.8

Corrected Copy

IMPERIAL IRRIGATION DISTRICT
ANNUAL INVENTORY OF AREAS RECEIVING WATER
YEARS 1984, 1983, 1982

I CROP SURVEY

GARDEN CROPS	<u>A C R E S</u>				<u>A C R E S</u>		
	<u>1984</u>	<u>1983</u>	<u>1982</u>		<u>1984</u>	<u>1983</u>	<u>1982</u>
Beans	0	79	165	Swiss Chard	6	0	1
Blackeyed Peas	0	85	0	Swiss Chard (Seed)	2	0	30
Broccoli	5 050	4 427	2 306	Tomatoes, Fall	0	0	18
Broccoli (Seed)	258	258	40	Tomatoes, Spring	4 604	2 822	3 053
Cabbage	350	31	444	Turnips	0	105	205
Cabbage, Chinese	9	32	22	Vegetables, Mixed	687	402	4
Cabbage (Seed)	0	37	198	Vegetables, Mixed (Seed)	249	0	35
Carrots	10 053	7 402	8 917	Waterlilies	16	16	17
Carrots (Seed)	36	104	218	Total	88 258	77 827	88 469
Cauliflower	942	151	84				
Cauliflower (Seed)	27	27	20	<u>FIELD CROPS</u>			
Celery	383	161	533	Alfalfa	216 687	205 138	202 190
Chicory	0	0	6	Alfalfa (Seed)	4 516	2 685	833
Collards	0	0	25	Alicia Grass	14	50	52
Cucumbers	146	137	155	Barley	259	259	232
Ear Corn	809	510	658	Bermuda Grass	2 786	2 816	3 684
Eggplant	0	18	2	Bermuda Grass (Seed)	13 175	16 428	7 845
Endive (Seed)	0	18	18	Clover	150	150	20
Fava Beans	0	27	54	Clover (Seed)	90	0	345
Fennel	0	3	3	Cotton	27 316	18 079	42 217
Flowers	262	187	229	Dichondra Grass	20	20	38
Flowers (Seed)	79	79	0	Field Corn	388	294	0
Garlic	523	376	306	Grass, Mixed	11	30	270
Herbs, Mixed	51	55	52	Oats	464	274	71
Herbs (Seed)	111	67	26	Rape	0	267	0
Lettuce	26 772	26 086	31 086	Rye Grass	6 717	2 540	4 891
Lettuce, Chinese	35	0	0	Rye Grass (Seed)	86	185	181
Lettuce (Seed)	382	382	77	Sail Cornia	0	10	1
Melons				Sesbania	75	75	1
Cantaloupes, Fall	5 110	5 319	6 547	Sesbania (Seed)	0	0	3
Cantaloupes (Seed)	157	141	44	Sorghum Grain	1 572	1 616	2 33
Cantaloupes, Spring	10 216	7 944	7 473	Sorghum Silage	861	552	58
Casaba, Fall	23	18	41	Soy Beans	5	0	18
Casaba, Spring	152	170	0	Spirulina Algae	32	12	
Crenshaw, Fall	578	366	873	Sudan Grass	24 311	10 410	8 01
Crenshaw, Spring	94	49	50	Sudan Grass (Seed)	115	228	
Honeydew, Fall	2 185	1 046	2 547	Sugar Beets	38 102	39 525	37 60
Honeydew (Seed)	24	0	0	Triticale Grain	0	0	5
Honeydew, Spring	140	388	370	Wheat	97 043	99 507	175 04
Kava Melons	4	21	10	Total	434 795	401 150	487 39
Mixed, Fall	953	860	662				
Mixed, Spring	115	270	135	<u>PERMANENT CROPS</u>			
Watermelons	4 656	4 972	5 354	Asparagus	3 541	2 992	2 45
Watermelons (Seed)	240	200	25	Citrus			
Mung Beans	0	0	33	Grapefruit	353	464	44
Mustard	19	38	148	Lemons	1 045	710	67
Mustard (Seed)	25	60	209	Mixed	203	390	15
Okra	146	96	188	Oranges	355	356	35
Okra (Seed)	43	96	466	Tangerines	51	113	1
Onions	7 887	7 248	10 013	Dates	103	132	1
Onions (Seed)	1 715	2 886	2 371	Duck Ponds (Feed)	8 866	12 908	8 11
Parsley	77	72	20	Fish Farms	784	1 196	71
Parsley (Seed)	0	0	79	Fruit, Mixed	3	21	1
Paranips	0	0	20	Grapes	30	30	
Peas	65	0	15	Guar Beans	0	0	1 81
Peas (Seed)	141	137	54	Jojoba	3 005	3 005	3 00
Peppers, Hot	0	0	8	Nursery	0	0	
Peppers, Sweet	179	120	12	Palms	9	13	
Radishes	27	11	149	Pasture, Permanent	473	449	3
Radishes (Seed)	123	167	28	Peaches	38	40	
Rappini	123	184	156	Pecans	33	40	
Rutabagas	0	36	40	Total	18 892	22 859	18 6
Sesame (Seed)	15	15	2				
Spinach	48	16	0				
Squash	1 009	797	1 286	Total Acres of Crops	541 945	501 836	594 4
Squash (Seed)	127	0	34				

Note: Crops are listed for the year in which they are predominately harvested.

SUMMARY

	<u>1984</u>		<u>1983</u>		<u>1982</u>
Number of Farm Accounts		6 866		6 997	6 91
Number of Owner-Operated Farm Accounts	(29.0%)	1 996	(32.0%)	2 225	2 11
Number of Tenant-Operated Farm Accounts	(71.0%)	4 870	(68.0%)	4 772	4 81
Average Acreage of Farm Accounts		71.53		73.67	70.1

II SUMMARY OF AREA SERVED

	<u>A C R E S</u>		
	<u>1984</u>	<u>1983</u>	<u>1982</u>
Field Crops	434 795	401 150	487 398
Garden Crops	88 258	77 827	88 469
Permanent Crops	<u>18 892</u>	<u>22 859</u>	<u>18 602</u>
Total Acres of Crops	541 945	501 836	594 469
Total Duplicate Crops	<u>96 223</u>	<u>61 089</u>	<u>133 113</u>
Total Net Acres in Crops	445 722	440 747	461 356
Area Being Reclaimed: Leached	<u>4 271</u>	<u>5 178</u>	<u>3 959</u>
Net Area Irrigated	449 993	445 925	465 315
Area Farmable but not Farmed during Year (Fallow Land)	<u>31 678</u>	<u>52 592</u>	<u>16 618</u>
Total Area Farmable	481 671	498 517	481 933
Area of Farms in Homes, Feed Lots, Corrals, Cotton Gins, Experimental Farms, and Industrial Areas	13 771	13 646	13 903
Areas in Cities, Towns, Airports, Cemeteries, Fairgrounds, Golf Courses, Recreational Parks, Lakes, and Rural Schools, Less Area Being Farmed	<u>16 308</u>	<u>16 047</u>	<u>14 508</u>
Total Area Receiving Water	511 750	528 210	510 344
Area in Drains, Canals, Rivers, Railroads, and Roads	74 056	74 018	73 513
Area below -230 Salton Sea Reserve Boundary and Area Covered by Salton Sea, Less Area Receiving Water	39 417	39 481	39 417
Area in Imperial Unit not Entitled to Water	63 933	63 933	63 933
Undeveloped Area of Imperial, West Mesa, East Mesa, and Pilot Knob Units	<u>286 105</u>	<u>269 619</u>	<u>288 054</u>
Total Acreage Included - All Units	975 261	975 261	975 261
*Acreage Not Included - All Units	<u>87 029</u>	<u>87 029</u>	<u>87 029</u>
Total Gross Acreage within District Boundaries	1 062 290	1 062 290	1 062 290

IMPERIAL IRRIGATION DISTRICT



J. R. WILSON, Manager
Water Department

*Acreage within District Boundaries that is not Included in District.

TABLE III.9
TONS OF SEDIMENT REMOVED BY DESILTING BASINS AT IMPERIAL DAM

Year	Total Annual Sediment (tons)	High Month	Monthly Total (tons)	Low Month	Monthly Total (tons)
1961	196,553	July	58,635	December	144
1962	337,927	July	81,120	December	338
1963	515,033	July	100,802	December	551
1964	392,573	July	120,565	December	331
1965	433,468	August	143,109	January	439
1966	542,921	July	180,225	January	455
1967	318,777	August	92,033	December	259
1968	459,410	March	130,290	December	481
1969	467,052	April	98,337	December	264
1970	445,798	April	180,957	November	858
1971	441,146	April	122,157	January	1,088
1972	439,086	April	138,713	December	1,351
1973	481,774	April	181,326	February	1,169
1974	626,447	April	201,486	January	1,103
1975	470,161	April	132,456	November	994
1976	556,506	April	199,599	January	1,276
1977	530,026	July	150,466	December	1,651
1978	522,696	July	154,504	January	461
1979	646,766	July	201,383	January	176
1980	3,535,757 ^a	July	1 331,953 ^a	January	1,436
1981	455,671	August	145,520	October	75
1982	39,475	April	100,176	December	75
1983 ^b	1,104,265 ^a	May	389,891	March	1,406
1984 ^c	-	-	-	-	-

^aCaused by extreme high River release.

^bJuly - Because of high water in Colorado River, the sediment pipes were submerged and no samples were taken.

^cBecause of continued high River releases during 1984, no samples could be taken.

acre-foot) of dissolved salts in the District's water supply (1 t.a.f. is equivalent to 735 ppm) is shown in Table III.10. A record of salinity of water supply (Drop No. 1) and drainage discharge waters, including a summary of salt balance, is shown in Table III.11. The impact of high salinity water is important to review. At high concentrations, it can prevent plant growth, corrode iron and brass plumbing, and concentrate in the soil.

The effect of other constituents in the water supply is also of significance. The constituents of a water sample from the All-American Canal below Drop No. 1 are given in Exhibit III.12. Each of these constituents can affect crop growth or adversely modify the soil structure. Water quality is as important as water quantity, and it is directly related to leaching requirements, drainage, and the types of crops that can be grown economically.

To maintain a favorable salt balance, water in excess of the consumptive use requirement must be utilized; this is called the leaching requirement. It is very important because of the magnitude of excess water that it requires. Typical values vary from 8 to 42 percent of total applied water. These values assume that the soil profile has been thoroughly reclaimed, i.e., excess salinity has already been leached out. In many areas of the Valley, the soil is still being reclaimed, so actual leaching requirements can exceed the theoretical, based on salt balance considerations. Exhibit III.13 illustrates tile line being installed.

Soil salinity is a continuing problem, but it has been reduced by installing leach lines throughout the Imperial Valley. In order to operate a leaching system properly, adequate amounts of water must be introduced. This is discussed in Chapter IV.

2. Consumptive Use

Consumptive use is a term that refers to the amount of water used by crops to build up plant tissue, transpired from the plant surface, and evaporated from the soil surface. Consumptive use will vary dramatically for the various crops and crop varieties, and it is affected by soil, climatic conditions, and the method of water application.

3. On-Farm Water Use

The actual on-farm use of water may be derived by adding the consumptive use and leaching requirements, and then dividing by the on-farm application efficiency. Table III.12 lists by major crops,

TABLE III.10
SALINITY OF WATER BELOW DROP NO. 1 ON ALL-AMERICAN CANAL

Year	Average ^a t.a.f.	Total Tons (millions)	Year	Average ^a t.a.f.	Total Tons (Millions)
1954	1.01	3.1	1970	1.27	3.5
1955	1.17	3.4	1971	1.27	3.7
1956	1.27	3.7	1972	1.24	3.5
1957	1.22	3.4	1973	1.18	3.5
1958	1.00	2.7	1974	1.19	3.7
1959	1.00	2.9	1975	1.19	3.6
1960	1.06	3.2	1976	1.17	3.3
1961	1.13	3.3	1977	1.13	3.0
1962	1.15	3.4	1978	1.08	2.9
1963	1.13	3.4	1979	1.15	3.2
1964	1.19	3.3	1980	1.10	3.1
1965	1.30	3.4	1981	1.15	3.2
1966	1.30	3.7	1982	1.16	2.9
1967	1.22	3.3	1983	1.05	2.5
1968	1.21	3.4	1984	1.00	2.7
1969	1.00	2.7			

^aWeighted average, salt concentrations.

TABLE III.11
SUMMARY OF SALT BALANCE
EXCLUDING WATER AND SALT FROM MEXICO

Year	INFLUENT ^a			EFFLUENT					Positive Salt Balance (tons)	Positive Salt Balance (tons)	% Gained
	Total Discharge (AF)	Salt Brought Into the Area (tons)	Weighted Average ^b T.A.F. ppm	Discharge (AF)	Total Discharge (AF)	Salt Removed (tons)	Weighted Average ^b T.A.F. ppm	Average ^b ppm			
1958	2,730,876	2,723,153	1.00	974,045	974,045	3,341,376	3.43	2,521	618,223	618,223	22.70
1959	2,840,173	2,852,019	1.00	1,020,963	1,020,963	3,401,652	3.33	2,448	549,633	549,633	19.27
1960	2,983,860	3,162,485	1.06	1,059,804	1,059,804	3,558,534	3.36	2,470	396,049	396,049	12.52
1961	2,957,200	3,330,087	1.13	1,050,700	1,050,700	3,572,808	3.40	2,499	242,721	242,721	7.29
1962	2,951,266	3,399,464	1.15	1,088,965	1,088,965	3,806,946	3.50	2,573	407,482	407,482	11.99
1963	2,991,429	3,378,583	1.13	1,153,827	1,153,827	4,050,087	3.51	2,580	671,504	671,504	19.88
1964	2,770,474	3,284,284	1.19	905,153	905,153	3,635,121	4.02	2,955	350,837	350,837	10.68
1965	2,624,363	3,406,457	1.30	882,962	882,962	3,819,255	4.33	3,183	412,798	412,798	12.12
1966	2,817,912	3,650,447	1.30	1,004,685	1,004,685	4,148,874	4.13	3,036	498,427	498,427	13.65
1967	2,719,861	3,306,261	1.22	1,027,970	1,027,970	4,139,477	4.03	2,962	833,216	833,216	25.20
1968	2,806,124	3,408,548	1.21	1,001,027	1,001,027	4,012,009	4.01	2,947	603,461	603,461	17.70
1969	2,675,833	3,396,105	1.27	962,639	962,639	3,754,477	3.90	2,867	358,372	358,372	10.55
1970	2,754,898	3,488,023	1.27	1,020,503	1,020,503	3,780,732	3.70	2,719	292,709	292,709	8.39
1971	2,883,969	3,666,277	1.27	1,092,571	1,092,571	3,900,990	3.57	2,624	234,713	234,713	6.40
1972 ^c	2,846,613	3,541,248	1.24	1,063,537	1,063,537	3,886,592	3.65	2,683	345,344	345,344	9.75
1973 ^c	2,956,013	3,492,199	1.18	1,065,414	1,065,414	3,980,338	3.74	2,749	488,139	488,139	13.98
1974 ^c	3,072,327	3,669,832	1.19	1,123,492	1,123,492	4,204,158	3.74	2,749	534,326	534,326	14.56
1975 ^c	3,001,207	3,581,043	1.19	1,128,268	1,128,268	4,196,407	3.72	2,734	615,364	615,364	17.18
1976 ^c	2,783,630	3,263,454	1.17	1,084,993	1,084,993	4,361,658	4.02	2,955	1,098,204	1,098,204	33.68
1977 ^c	2,693,030	3,039,155	1.13	1,020,797	1,020,797	4,187,227	4.10	3,014	1,148,072	1,148,072	37.78
1978 ^c	2,671,798	2,897,906	1.08	995,674	995,674	3,824,323	3.84	2,823	926,417	926,417	31.97
1979 ^c	2,803,166	3,216,228	1.15	1,056,652	1,056,652	3,998,131	3.78	2,781	781,903	781,903	24.31
1980 ^c	2,769,495	3,058,785	1.10	1,043,241	1,043,241	3,988,611	3.82	2,810	929,826	929,826	30.40
1981 ^c	2,769,112	3,192,402	1.15	962,925	962,925	3,825,050	3.97	2,920	632,648	632,648	19.82
1982 ^c	2,515,637	2,918,781	1.16	888,575	888,575	3,608,490	4.06	2,985	689,709	689,709	23.63
1983 ^c	2,416,885	2,538,349	1.05	867,835	867,835	3,333,260	3.84	2,822	794,911	794,911	31.32
1984 ^c	2,647,285	2,654,712	1.00	895,034	895,034	3,360,256	3.75	2,759	705,544	705,544	26.58

Note: Part of the water in Alamo River from Mexico was used for irrigation in the United States prior to January 4, 1958. Prior to January 1, 1970, all salt concentrations were obtained by evaporation and drying at 105°C. Subsequent to January 1970, concentrations were obtained by drying at 180°C.

^aBased on weekly samples at All-American Canal Station 2963 (East Highline Check) 1958 through 1972

^bppm = 735 x T.A.F.

^cBased on weekly samples at All-American Canal below Drop No. 1.

IID-442H
(R3 2-70)

LABORATORY CERTIFICATE
IMPERIAL IRRIGATION DISTRICT

Constituents of Water at Drop No. 1
Testing Laboratory
Imperial, California

LABORATORY
NO. 100042

Date Received November 7, 1984

Date Sampled November 7, 1984

Date Tested November 13, 1984

Sampled By Gawat & Granado

Description AAC Below Drop #1

Discharge 1645 c.f.s.

Time 9:30 a.m.

Temperature 62°

DETERMINATIONS

Total Dissolved Solids (Dried @ 180° C.) T.A.F. 0.91 p.p.m. 666
K x 10⁶ @ 25° C. 1010
pH 8.8

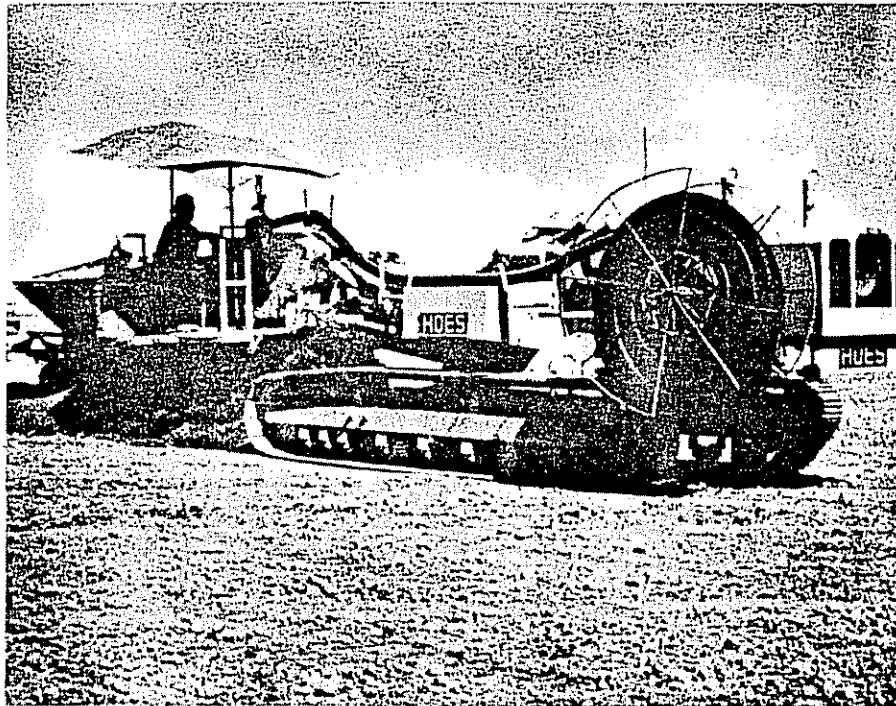
S.A.R. = 1.84

	<u>p.p.m.</u>	<u>e.p.m.</u>	<u>% e.p.m. Cations</u>
Ca	79	3.96	40
Mg	33	2.68	33
Na+K	<u>77</u>	3.36	33
	189		

			<u>% e.p.m. Anions</u>
HCO ₃	107	1.76	18
SO ₄	237	4.94	49
Cl	<u>117</u>	3.30	33
	461		
	<u>650</u>		
-1/2 HCO ₃	53		
	<u>597</u>		

Eng. Files
LAB21

Exhibit III.12



28,971 MILES OF TILE HAVE BEEN INSTALLED TO LEACH OUT ACCUMULATING
SALTS.

TABLE III.12
TOTAL AGRICULTURAL WATER USE

Crop	(1)		(2)		(3)	
	Acreage, 1974 - 1983 (Acres X 1000)		Consumptive Use		Leaching Requirement	
	Range	Mean	(Acre-Feet Per Acre)		(Acre-Feet Per Acre)	Total Requirement, Assuming 100% Application Efficiency (Acre-Feet Per Acre)
Alfalfa	158 - 208	181.0	6.0	1.1	7.1	
Barley	0 - 7.5	3.5	1.8	0.2	2.0	
Cotton	18 - 138	69.5	3.6	0.3	3.9	
Sorghum, Grain	1.5 - 31.5	11.5	2.5	0.3	2.8	
Sudan	6.5 - 26	16.0	2.5	0.3	2.8	
Sugar Beets	36.5 - 74	51.5	3.7	0.3	4.0	
Wheat	67.5 - 175	129.0	2.1	0.2	2.3	
Misc. Field Crops	8.5 - 23.5	15.5	2.5	0.4	2.9	
Melons	11 - 24	16.5	2.3	1.2	3.5	
Lettuce	26.5 - 48.5	40.0	1.4	0.5	1.9	
Carrots	4.5 - 9	7.0	1.3	0.6	1.9	
Tomatoes	1.5 - 6	3.5	2.3	0.4	2.7	
Misc. Garden Crops	11 - 21.5	16.0	1.7	0.4	2.1	
Citrus	1.5 - 2.5	2.0	3.8	2.6	6.4	
Misc. Permanent Crops	11.5 - 21	14.0	4.2	2.9	7.1	
TOTAL ACREAGE		576.5				
AVERAGE			3.7	0.6	4.3	

(1) = Rounded to nearest 500 acres.

(2) = Kaddah, M. T. and Rhoades, J. D., 1976, Salt and Water Balance in Imperial Valley, California
Soil Science Society of American Journal, v. 40, No. 1, pages 93-100.

(3) = Based on 10-year average EC of incoming irrigation water of 1.22 mmhos/cm, and the EC of soil
saturation extract that will reduce crop yield, by not more than 10% from Drainage of Agriculture
edited by J. V. Schilfgaarde, p. 73, and U.S.D.A. Bulletin No. 283, pages 10-12.

the minimum, maximum, and mean values of acreages, consumptive use, and leaching requirements as determined by local studies.

4. Agricultural Practices

a. Land Preparation

- (1) Cultural Practices: Cultural practices vary for different crop categories (i.e., grains, vegetables, melons, etc.) as well as with individual growers and various locations within the District boundaries. However, general practice includes the use of a stubble disk to incorporate previous crop residue into the soil for decomposition and to aid in smoothing the surface for subsequent tillage operations for row crops. A moldboard plow (or a subsoiler), a vertical shank which is drawn through the soil, is then used to promote aeration and water penetration for the following crop. This operation is necessary because of the contents of clay strata in the soil profile and compaction from various cultivation and harvesting operations of the previous crop.

The next step is usually the use of a disk harrow, with the disk operation done in two steps, the second phase being at an angle to the first. This operation is performed to further incorporate previous crop residues into the soil and to reduce clod size to a more desirable and uniform surface texture.

The next operation usually consists of minor leveling by a "floating" or "planing" process. This step results in a more uniform surface gradient and furthers the process of reducing clod size, permitting a more even distribution of irrigation water during subsequent cropping.

The next operation usually consists of constructing borders and irrigating by flood method, prior to planting the crop. This is done for various reasons: germination of weed seeds, decomposition of organic matter in the soil, and production of a more desirable surface texture for the seed bed.

If the crop is to be furrow irrigated, rows are then constructed and a mechanical incorporator is used frequently to apply herbicides and prepare the seed bed. The seed is then placed in the soil and either sprinkled or furrow irrigated to germinate the crop.

- (2) Deep Tillage: Soil compaction is a common problem in the Valley. Deep tillage must be done frequently to break up the compacted layers. Three basic types of deep tillage are used in the Valley: chiseling, slip plowing, and deep plowing.

Chiseling is normally done once each year to break up the compacted 30 inches of the topsoil. This procedure is accomplished by pulling three shanks 3 feet apart through the soil at a depth of 30 inches.

In some soils, it is desirable to restructure the soil stratum by use of a "slip plow," which is designed to bring coarse soil particles up through the finer soil layers to enhance water and root penetration. This operation is usually done not more than twice on any given area to produce the desired effects.

Deep plowing to a depth of 5 feet is done to mix the fine and coarse soil particles in order to improve soil structure and water and root penetration. This operation is only done once on any given area.

- (3) Land Leveling: In addition to the seasonal methods previously mentioned, there is usually at least one major leveling process conducted with large earthmovers to produce a finished grade, determined by soil texture and future intended use of the area being leveled. Most of the leveling is now done using laser beams to control the operation. Laser leveling makes it possible to level the field with 0.1 of an inch precision (see Exhibit III.14).

Many farmers have bought their own laser equipment, and "touch up" their fields each year to maintain precision leveling in order to evenly distribute and conserve water.

b. Irrigation Practices

Because less than 3 inches of rain fall annually in the Valley, irrigation is the most important management practice of the farmer. Crops grown in the Valley vary all the way from field crops to vegetables, and the methods used to irrigate these crops vary accordingly:

- (1) Sprinkler Irrigation: Sprinklers are used mainly in the Valley to germinate vegetable crops by providing a microclimate around the young seedling that is conducive to

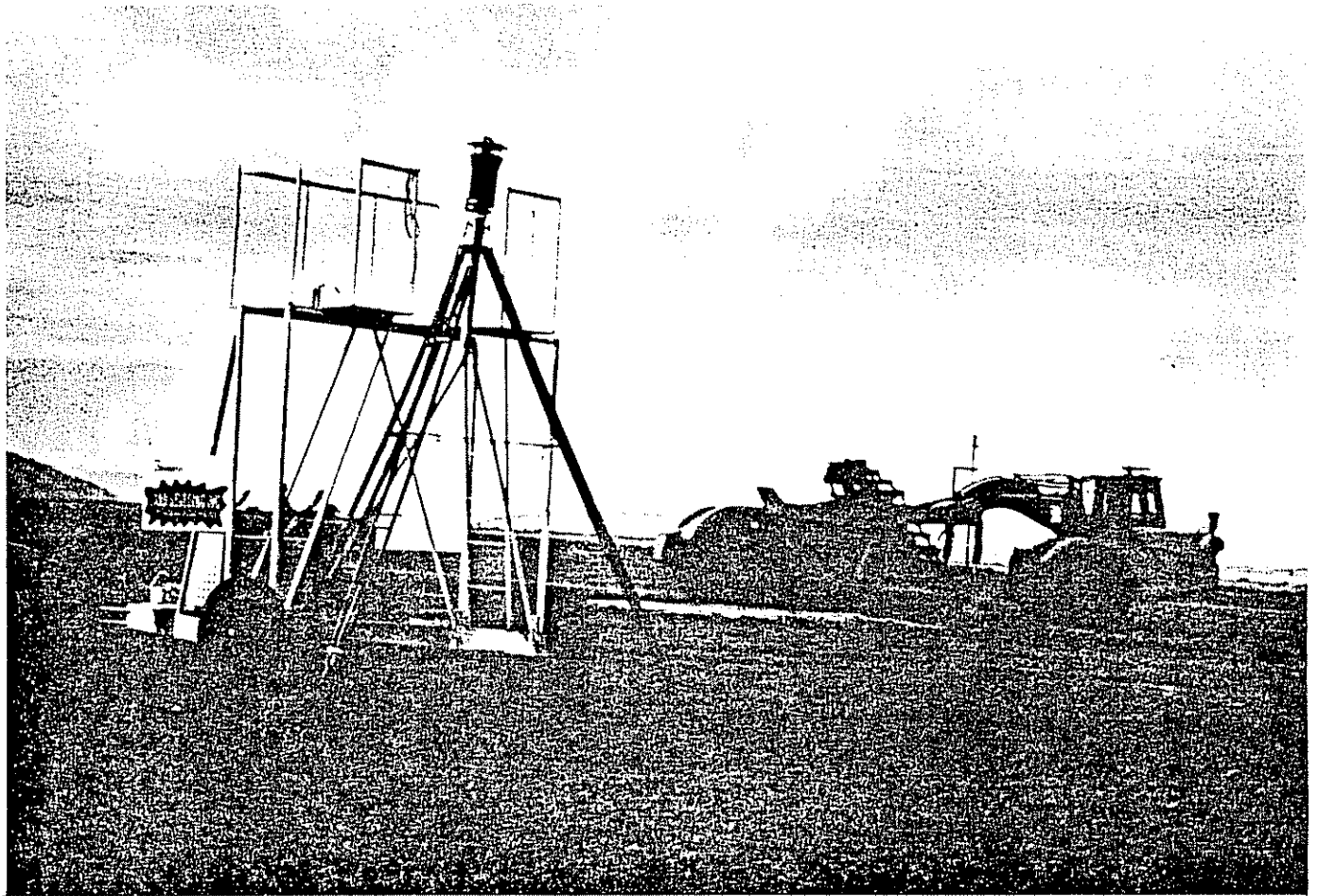
early growth. Potential irrigation efficiency using sprinklers on Valley soils is only 65-75 percent because of the distribution uniformity problems inherent in sprinklers and very high evaporation losses. After establishing a stand, more efficient methods such as furrow irrigation are used.

- (2) Furrow Irrigation: Furrow and border irrigation are the two most widely used methods of irrigating in the Valley. Furrow irrigation is accomplished by running water in small channels (furrows) down or across the slope of the field. The water infiltrates the bottom and sides of the furrows to provide the desired soil wetting. Land leveling to provide uniform slopes is required to achieve high efficiencies in furrow irrigation.

Furrows are particularly suitable for irrigating crops that are susceptible to injury if the crown or stems become submerged. In contrast to flooding, furrow irrigation does not wet the entire soil surface; therefore, more time must be allowed for the water to soak in. Labor in this method is greater than border irrigation, but much less than sprinkler or drip irrigation.

- (3) Border Irrigation: Border irrigation uses parallel earth levees or borders to guide a sheet of water as it moves down the slope. The land between two levees is called a border strip. Border strips vary from 10-150 feet in width and from 1,000-5,000 feet in length. This method is often the most efficient for irrigation of densely growing crops such as alfalfa and wheat. It is essential that the land has very little side fall, and the surface must be even to achieve high irrigation efficiencies.

- (4) Corrugation Irrigation: In corrugation irrigation, the water flows down the slope in small furrows called corrugations or rills. This method is used on steep ground for irrigating crops such as small pasture and alfalfa. The corrugations are V- or U-shaped channels about 2-3 inches deep, spaced 12-40 inches apart. The entire soil surface is wetted as the water moves laterally through the soil. This method of wetting the soil is commonly used to germinate crops that have been drill or broadcast seeded, because it minimizes the crusting effect on the surface. Flood irrigation is then used after the plants become established.



LASER LAND LEVELING IMPROVES WATER APPLICATION UNIFORMITY AND EFFICIENCY.

- (5) Basin Irrigation: Basin (or dead-level irrigation) is relatively new to the Valley, but it is the simplest in principle of all methods, and labor is minimal. Levees (dikes or borders) are constructed around the areas forming basins. However, land is removed from production, and levees interfere with the movement of farm equipment. The land inside the basin is level or has a very small amount of fall. A 70-acre field will normally be divided into six individual basins. Many different crops are irrigated by this method. Plants that would be damaged by submergence are grown on beds, and the water flows in the furrows.

Dead-level irrigation is aptly named. About 80 percent of the Valley soils are heavy clays and seal over when wetted (USDA/SCS, 1981). Because of very slow infiltration rates, if excess water is applied or if a storm occurs after an irrigation, water will pond on the surface for long periods of time. In most cases, this will seriously injure or kill the crop. Extremely careful water management is necessary on clay soils with basin irrigation.

- (6) Drip Irrigation: The application of water to the soil through small orifices is known as drip, trickle, spitter or dribble irrigation. The orifices normally deliver water through emitters to a specific area at rates of 0.25 to 2 gallons per hour. Water is delivered through small plastic pipes to the orifices laid on the ground or buried. Water is normally applied at short intervals to meet the consumptive use needs of the crop. Drip systems must have screens and filters to remove aquatic vegetation debris and suspended particles, which would plug the small emitters. Fertilizer is usually injected into the system. The plugging of emitters can be a problem and requires constant checking to ensure that all of the plants are receiving enough water.

Drip irrigation is used on sandy soils and on some citrus and high cash crops in the Valley. Salt accumulation at the perimeter of the wetted area occurs and must be leached from the root zone, either by overapplication through the drip system or periodic flooding of the soil. Extreme caution must be exercised during rainstorms. Rains can cause the accumulated salts to migrate back into the root zone, and severe crop damage or failure can occur. It is a general practice to run water through the drip system during a storm to prevent the migration of the salts back into the root

zone. This obviously reduces the efficiency of the drip system. A storage reservoir is required when using a drip system.

- (7) Tailwater Return: Tailwater return, sometimes referred to as pumpback, can be used with most of the preceding methods of irrigation. Tailwater (the excess water that collects at the lower end of the field) is normally stored for a few hours and pumped back to the upper end of the field where it is mixed with incoming water and used to irrigate other portions of the field. Careful water management is important when using a pumpback system.

c. Irrigation Scheduling Methods

When to irrigate and how much to apply are two basic questions asked by the irrigator. Irrigations must be scheduled often enough to keep the plant alive and producing well. The amount of water applied during each irrigation is a function of the soil type, system efficiency and irrigation frequency.

There are four basic methods used to schedule irrigations in the Valley. They range from observing the plants to complex computer modeling. Each method has advantages and disadvantages:

- (1) Crop Appearance Method: Crop appearance has been used to schedule irrigations for many years. It is based on a change in plant appearance or color when associated with stress. For some crops, this method has been somewhat successful; however, by the time some plants show signs of stress, it is too late and yield is reduced. This method gives some indication when to irrigate but not how much to apply.
- (2) Calendar Method: The crop is irrigated at a set frequency on a certain number of calendar days. Scheduling with this type of system is very simple. Unfortunately, irrigation efficiency and production can suffer under this type of system. This method does not indicate how much water should be applied and could result in overapplication of water or severe plant stress between irrigations.
- (3) ET (evapotranspiration) Method (Water Budget Method): This method involves determining the daily ET loss for each crop and subtracting that amount from the available soil moisture in the plant root zone. This accounting (or budget) method allows the grower to keep track of the soil moisture

conditions in each field and predict several days in advance when an irrigation is needed and how much water to apply.

Various methods have been developed to estimate the amount of water used each day by a crop at a specific site. Some methods involve incoming radiation, wind speed, temperature and humidity measurements. One relatively simple approach has been to relate a crop's daily consumptive use to the evaporation loss from a Class A Weather Bureau evaporation pan. Daily pan evaporation values are listed in the local newspaper each day.

The Water Budget Method must be closely correlated with soil type, salinity, fertilization and stage of growth. It is a good method for scheduling irrigation but must be continually compared to the actual conditions existing in the field.

- (4) Allowable Soil Moisture Depletion Method: Soils will only hold a certain amount of water that is available for plant use. This is usually referred to as the available water-holding capacity (AWC) of the soil and is closely related to texture (Table III.13). In the Allowable Depletion Method, a certain percentage of this moisture is allowed to be depleted from the plant root zone before an irrigation is scheduled. The amount of water to be replaced during each irrigation is the amount depleted from the soil since the last irrigation.

One way of estimating the soil moisture content is by the "feel" method (Table III.14). Other more accurate methods of estimating soil moisture depletion involve the use of tensiometers, conductance cells, oven-drying soil samples, and the neutron soil moisture probe. The District currently has a demonstration irrigation scheduling program using the neutron probe. The unit irrigation efficiency in this demonstration program is currently 86 percent.

D. OTHER WATER USES

1. Municipal Water Use

The District delivers water to a variety of ultimate users, not only to farmers. Nine cities and towns are delivered water on a wholesale basis directly from canals to each town's treatment facility (Table III.15).

TABLE III.13
IRRIGATION WATER MANAGEMENT

Conservation irrigation water management is the act of controlling or regulating irrigation water applications in a way that will satisfy the water requirements of the crop without the waste of either water or soil. It involves applying water in accordance with crop needs, in amounts that can be retained in the soil for crop use, and at rates that are consistent with the intake characteristics of the soil and the erosion hazard of the site.

The table below gives the general range of available moisture-holding capacities of the various soil textures when unaffected by salts.

Soil Texture	Available Moisture ^{1/}	
	Range In./Ft.	Average In./Ft.
Very Coarse to Coarse Textured Sand	0.4 - 1.00	0.80
Moderately Coarse Textured Sandy Loams and Fine Sandy Loams	1.00 - 1.50	1.20
Medium Texture - Very Fine Sandy Loams to Silty Clay Loam	1.50 - 2.30	2.00
Fine and Very Fine Texture - Silty Clay to Clay	1.50 - 2.00	1.80
Peats and Mucks	2.00 - 3.00	2.50

Soil textures existing in your fields can be found in your conservation plan. If you do not have one, check at the local Soil Conservation Service office.

The available moisture in saline soil should be reduced according to the table below:

ESTIMATING REDUCTION OF AVAILABLE MOISTURE IN SALINE SOILS^{2/}

Conductivity of Soil Saturation extract Millimhos/cm (EC x 10 ³)	0	2	4	6	8	10	12	14	16
Approximate Reduction in Available Moisture = percent	0	5	11	19	28	38	52	68	84

^{1/} Revised in accordance with Technical Note, Soils-15, dated June 1969 with attachments dated May 20, 1976.

^{2/} From "A Proposed Method for Estimating Reduction of Available Moisture in Saline Soils" by Robert E. Fox, USDA-Soil Conservation Service, Soil Science, Vol 83 page 453, June 1957.

TABLE III.14
GUIDE FOR ESTIMATING AVAILABLE SOIL MOISTURE BY THE "FEEL" METHOD

Available soil moisture remaining	Feel or appearance of soil			
	Coarse Texture	Moderately Coarse Texture	Medium Texture	Fine and Very Fine Texture
0 to 25 percent	Dry, loose, single grained, flows through fingers	Dry, loose, flows through fingers	Powdery dry, sometimes slightly crusted but easily broken down into powdery condition	Hard, baked, cracked, sometimes has loose crumbs on surface
25 to 50 percent	Appears to be dry, will not form a ball with pressure <u>1/</u>	Appears to be dry, will not form a ball <u>1/</u>	Somewhat crumbly but holds together from pressure	Somewhat pliable, will ball under pressure <u>1/</u>
50 to 75 percent	Appears to be dry, will not form a ball with pressure	Tends to ball under pressure but seldom holds together	Forms a ball, somewhat plastic, will sometimes slick slightly with pressure	Forms a ball, ribbons out between thumb and fore-finger
75 percent to field capacity (100%)	Tends to stick together slightly, sometimes forms a very weak ball pressure	Forms weak ball, breaks easily, will not slick	Forms a ball, is very pliable, slicks readily if relatively high in clay	Easily ribbons out between fingers, has slick feeling
At field capacity (100%)	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand

1/ Ball is formed by squeezing a handful of soil very firmly.

TABLE III.15
MUNICIPAL WATER CONSUMPTION (1983)

Town or City	Water Delivered Acre-Feet	Population	Gallons/ Capita/Day
Calexico	5,110.0	15,838	288
Holtville	1,516.4	4,637	292
El Centro	6,239.8	26,402	211
Imperial	2,067.0	3,708	498
Brawley	7,960.0	17,160	414
Westmorland	1,102.0	1,718	573
Calipatria	1,337.0	2,706	441
Niland	789.0	1,042	676
Seeley	346.0	1,058	292
Heber	345.0	2,221	139
U.S. Naval Air Station	811.5	2,315	313
TOTALS	27,623.7	78,805	

Note: Population figures are from Imperial Irrigation District's Community and Special Services Section, February 1984. Official Preliminary 1983 Census Results are from the County Planner.

Farmers in rural areas and rural communities also receive water directly from the canal system, treating it as necessary. Water charges are made annually. There are 19,479 residents living in the nonurban areas of the District's water service area using approximately 8,400 AF of water per year. Since water deliveries to rural customers are not measured, this quantity is based on the average county-wide usage rate.

2. Industrial Water Use

Almost all industry in Imperial Valley, excluding geothermal developments, is located within urban areas. The industrial users of water include: Holly Sugar Corporation, various cotton gins and compresses, chemical/fertilizer producers, and a steam turbine electrical generating station. The approximate annual industrial water use is 1,000 AF.

The development of geothermal resources requires water for cooling and reinjection. Imperial County requires reinjection to reduce the possibility of land subsidence. Currently there are three 10-MW pilot plants operating in Imperial Valley; two 50-MW plants are near completion, south of Heber. The water use for 1984 was 1,100 AF.

The initial development stages indicate that water usage by geothermal power plants varies with the temperature of the resource but will average 60 AF per year per megawatt of plant capacity under normal operating conditions. Development to the predicted 3,000 MW will require about 180,000 AF. If steam condensate is not used for cooling throughout the Valley, adverse impacts to water availability and quality could occur. However, if steam condensate is used for cooling at full field development for the entire geothermal resources and less than 100-percent reinjection is permitted, no outside sources of cooling water will be required, and no adverse water supply impacts will occur (ICPD, 1977).

3. Recreational and Wildlife Water Use

Recreational use of water outside of city boundaries includes lakes, parks and golf courses. The approximate annual water use by recreational facilities follows:

<u>Location</u>	<u>Acre-Feet per Year</u>
Wiest Lake and Park	726
Sunbeam Lake and Park	1,034
Finney Lake	1,614
Ramer Lake	1,696
Del Rio Country Club	994
Barbara Worth Country Club	695
International Country Club	382
Total	7,141

Wildlife use consists mainly of wetlands habitat enhancement areas. The California Department of Fish and Game maintains approximately 1,400 acres of waterfowl habitat and 360 acres of fish hatcheries. The District also maintains a 100-acre pond in the New River bottom for wildlife habitat. The approximate annual water use for these fish and habitat areas is 13,000 AF in evaporation and seepage per year. Other bulk users of water in the rural areas of Imperial County include schools and cemeteries. Approximate usages are listed below:

<u>User</u>	<u>Acre-Feet per Year</u>
Riverview Cemetery	269
Memorial Park Cemetery	39
Central Valley Cemetery (Holtville)	16
Central Valley Cemetery (El Centro)	27
Imperial Valley College	400
Meadows Union School	120
Westside School	84
Mulberry School	110
McCabe School	120
Pine Union School	60
Total	1,245

E. SUMMARY

The development of the Imperial Irrigation District as described in previous chapters has culminated in a continually improving system. Wherever possible, improvements are made on the structural elements of both the irrigation and drainage systems. Operational improvements are also incorporated to take advantage of the changing aspects of the system. Rules and Regulations have been adopted and enforced to maintain operational efficiency. These include special water conservation measures put into effect within the last 10 years.

The District has looked at system-wide water usage and has focused on its largest customer, the agricultural user. Irrigation practices have been investigated and, wherever feasible, improvements have been encouraged. Other water users, including municipalities and industry, are being monitored and have been taken into consideration in this description of the water systems of the Valley.

**CHAPTER IV
PAST WATER
CONSERVATION PROGRAMS**

CHAPTER IV

PAST WATER CONSERVATION PROGRAMS

A. INTRODUCTION

The District must deliver a reliable water supply to a user in the quantity required. The agricultural water user must satisfy complex and variable climatic, crop, soil, salinity and operational requirements. Improvement of water use efficiency accomplishes several purposes, at the District or water user level, and may involve operational and physical changes. However, any action that improves the forecasting of the water need increases the reliability of the water supply, decreases operation and maintenance needs in an economical manner, contributes to effective water management and use, and conserves water. The District and its users have a long history of improving water use efficiency.

Major water conservation programs that are followed by an irrigation district usually require changes in routine at the policy and management level, at the operation and maintenance level, and at the water user level. Changes must be accomplished in a well-planned and orderly fashion, especially in a large and complex district such as Imperial, where large quantities of water are handled. Lands are located far from the water source and are irrigated 12 months out of the year. High-value crops are produced that are often highly sensitive to management of soil, moisture and salinity. Any program measure that disrupts established practices and procedures, or attempts to implement structural changes to existing distribution systems more rapidly than District personnel and landowners can adapt, may well result in an overall failure of the water conservation program. The degree of failure can be measured in crop losses, excessive District costs, and poor relations between the District and the landowners it serves.

The benefits of some water conservation programs that are desirable both to water users and the District are difficult to quantify. The District's canal-lining program falls in this category. In addition to reducing seepage losses, which cannot be quantified readily, lined canals are more economical to operate and maintain than dirt ditches. Farmers prefer lined canals because they reduce seepage damage to adjacent lands, reduce the lands needed for rights-of-way, and increase land available for farming. Where farmers are responsible for maintenance, costs are reduced. The rate at which mutually financed programs can proceed is

levels by the USGS in 1927, President Coolidge set aside about 120,000 acres of land below elevation -220 feet under public domain. This area, coupled with land and flood easements subsequently owned by the District, effectively covers nearly all of the land below elevation -220 feet.

District resources, both financial and physical, were expended during the late 1920s to construct an open drainage system, and, by the end of 1930, 234 miles of deep drains and 740 miles of lateral drains had been completed. At that time, the District was operating and maintaining about 1,600 miles of earth-lined irrigation canals and laterals in Imperial Valley, basically the same system in operation today. In addition, through its Mexican company, it was operating and maintaining 130 miles of earth-lined canals and about 75 miles of protective levees along the Colorado River, 45 miles of which were equipped with a standard-gauge railroad. Silt removal from the canal system required much time and expense.

Recognizing the need to avoid excessive tailwater discharge by water users, the District has periodically adopted Resolutions, as well as Rules and Regulations, toward this purpose. Regulation No. 34 in District Rules and Regulations adopted in 1922 states:

"... water users wasting water on roads or vacant land, or land previously irrigated, either willfully, carelessly, or on account of defective ditches, or who shall flood certain portions of the land to an unreasonable depth or amount ...will be refused the use of water until such conditions are remedied."

In 1933, after the drainage system was completed, the Board of Directors adopted a resolution that permitted the District to refuse water service to any water user who intentionally or carelessly permitted discharge of excess irrigation water into drains.

The 1930s and 1940s were extremely difficult times. The nationwide depression of the 1930s resulted in great financial stress to both Valley farmers and the District. Then, in 1934, a severe water shortage caused crop losses and additional hardships, and financial problems continued through the decade. In 1939, a hurricane swept through the Valley, dropping nearly 7 inches of rain almost continuously for a week. Great damage was done to the District's systems. In May 1940, the most severe earthquake of the century caused substantial damage to cities and towns. Several lives were lost. Again, extensive damage to District facilities took place, mainly to the Solfatara Canal in Mexico. The newly completed All-American Canal sustained a horizontal shift of over 14 feet in its right bank not far from Calexico. Substantial time and money were expended to make repairs.

The District began to improve its system after the All-American Canal was completed in 1941. (This canal was the first to provide the Valley with a reduced-silt water supply.) Old timber structures were replaced with concrete. Corrugated metal pipes in culverts and flumes were replaced with concrete pipe. Imperial County improved its road system by constructing numerous bridges and cooperating with the District in replacing old siphons. As those roads were paved, the District's operations improved due to better access to checks and delivery structures.

D. OVERVIEW OF WATER CONSERVATION

During the past four decades, the District has initiated many water conservation programs and has participated in various programs in cooperation with government agencies. Various structural programs have been initiated and continued by the District in cooperation with private individuals and public entities. Operational and administrative programs designed to conserve water have been put into practice. In addition to taking part in cooperative ventures, the District has offered public education programs and has encouraged innovative on-farm irrigation practices. These programs are described within this chapter and form the foundation of future water conservation plans.

Water not consumed or lost in farm and District operations is:

1. Leach water is irrigation water that is in excess of consumptive-crop needs required to leach salts below the root zone. It percolates through the soil, enters the on-farm drainage systems, and is then discharged into the District drains.
2. Tailwater is irrigation water that runs off the lower end of the fields and is discharged into the open drains by gravity or pumping.
3. Operational spills result from an imbalance of canal flow and diversions to landowners.
4. Canal seepage results from unlined canals.

Items 1 and 2 are not directly controlled by the District, and farmers must be relied upon to use their water in a reasonable manner. However, the District historically has encouraged efficient on-farm water use by enforcing rules and regulations designed to limit overapplication of water at the on-farm level. Items 3 and 4 are the District's responsibility, and the District is continually taking steps to reduce them. Leaching is necessary for farm operations, and current testimony indicates that the actual leaching is about equal to theoretical requirements.

Canal seepage is being reduced through canal lining. Tailwater and canal spill are interrelated. Tailwater may be increased if farm headgate deliveries fluctuate, more water is ordered than needed, or more water is delivered than ordered (consumptive need may be miscalculated). A reduction in tailwater can be made if headgate deliveries are better controlled. Improved headgate control can be obtained by carrying extra water in the canal, hence some canal spill. One important method to reduce spill and tailwater is to provide better control to the farmers' headgates. Several structural and nonstructural elements contribute to water control; however, the effects are hard to measure.

The District's basic responsibility of delivering water when, where, and in the quantities needed has provided an efficient water delivery system compared to similar districts.

E. WATER MEASUREMENT PROGRAM

The District has developed a highly integrated water measurement program to accurately control flows for proper delivery of water to the farmers. Hydrographers make periodic current flow measurements as needed for control. Since its inception, the District has maintained an extensive measurement program not only of water quantities but also of water quality, District and farm facilities, crop patterns, and meteorological and hydrological conditions, including Salton Sea records. A water report is published annually that summarizes the measurements.

Water measurements are conducted in accordance with standards developed by the District, in compliance with accepted hydrologic criteria, and as required by cooperating agencies, including the USGS, National Oceanic and Atmospheric Administration, International Boundary and Water Commission, the USBR, University of California, and Resources Agency of California. During the last few years, there has been an increase in measurements into other areas. These include installation of continuous recording devices on a sample number of canal spills, canal laterals, farm deliveries and tailwater boxes.

F. STRUCTURAL PROGRAMS

Structural programs to conserve water include physical changes to the water conveyance and usage system that will bring about benefits independently of user practices. An example would be the lining of canals to reduce seepage losses.

1. Canal Lining

In 1954, the District began a program of concrete lining canals and laterals. The program provided that the landowner submit a request to the District to concrete line the reach of canal contiguous to his land, agree to pay a share varying from 25 to 30 percent of the lining cost, and furnish rights-of-way and earthfill as necessary for construction of the embankment. Under this program, 871 miles of canals and laterals (over one-half of the District's water conveyance system) have been concrete lined through 1984 (Table III.3). The cost-sharing program between the landowner and the District had two beneficial aspects regarding water conservation. First, where canal seepage was causing a problem, a landowner would request that a canal be lined; hence, some of the canals with high seepage rates were lined under the program. Second, by using a cost-sharing program, the net result was that more miles of canal were lined and there were greater savings in seepage losses. Cost savings to the District have not been determined because no values have been placed on farmer-supplied earthfill. Considering haul distances, this could be the most costly item.

In addition to concrete lining, about 9 miles of laterals have been replaced with concrete pipe, primarily through portions of the Cities of Brawley, El Centro and Holtville.

It is difficult to estimate the reduction of seepage resulting from canal lining. The seepage per mile of lateral derived from a USBR study on canal lining averages 135 AF per year (USBR, 1984). Using this number, the practice of lining canals is currently saving about 118,000 AF per year (871 miles x 135 AF), creating a total savings of 1.6 MAF from 1954 through 1983. This estimate is probably low because the canals that have been lined include some of the most permeable areas.

In addition to lining the District's lateral canals, about 80 percent of farm head ditches have been lined. The District uses private contractors to line its canals so that contractors are available in the Valley for farm ditch lining.

2. Regulatory Reservoirs

The District has four regulating reservoirs in operation providing a total storage capacity of 1,570 AF. One reservoir is located on each of the three main canals - East Highline, Central Main and Westside Main. The fourth and newest reservoir, the Herman "Red" Sperber Reservoir, began operating May 1, 1983, and stores water from the

Rositas Canal. A total of \$3.3 million was spent for construction of the four reservoirs.

These reservoirs are all located near former spill locations (laterals discharging into drains or other laterals). Reservoirs reduce canal spill at other locations because they provide for better control. The only direct savings credited to reservoirs are the changes in annual amounts of spill at those locations. Table IV.1 lists the pertinent information on the four reservoirs.

TABLE IV.1
COMPARISON OF REGULATORY RESERVOIRS

Reservoir	Year Completed	Capacity (AF)	Direct Savings ^a (AF)	Cumulative Storage 1984 (AF)
Singh	1976	350	400	29,109
Sheldon	1977	500	1,300	24,221
Fudge	1982	320	2,400	24,937
Sperber	1983	400	2,100	24,518
Totals		1,570	6,200	102,785

^aEstimated reduction in annual spill

3. Seepage Recovery Lines

The District has constructed 6 miles (twelve 0.5-mile sections) of seepage recovery lines parallel to the East Highline Canal to recover canal seepage losses. Water entering these lines is pumped back into the canal for delivery to farms. Through 1984, it is estimated that nearly 210,000 AF have been returned to the distribution system. Total expenditures for seepage recovery lines were \$492,000. Approximately \$50,000 per year is budgeted for operation, maintenance and power costs associated with the seepage recovery program. A summary of annual amounts of water conserved by these seepage recovery systems is shown in Table IV.2.

4. Farm Delivery and Outlet Structures

Since 1976, farm delivery structures have been installed or reconstructed using standard designs to provide for better water control and measurement of farm deliveries and to facilitate measurement of tailwater runoff. Farm drain outlet structures are owned and maintained by the landowners.

TABLE IV.2

WATER RECOVERY DRAINS PARALLEL TO EAST HIGHLINE CANAL

Year	DP-17			DP-18			DP-19			DP-20			DP-21			DP-22			DP-23		
	Plum to Pine			Pear to EHL Lat. 10			EHL Lat. 10 to Lat. 11			Oat to Oasias			Highway 80 to EHL Lat. 8			EHL Lat. 8 to Pear			Oak to Moss		
	Acre-Feet Recovered	Cost		Acre-Feet Recovered	Cost		Acre-Feet Recovered	Cost		Acre-Feet Recovered	Cost		Acre-Feet Recovered	Cost		Acre-Feet Recovered	Cost		Acre-Feet Recovered	Cost	
May to Dec. 1967	736	\$ 287		467	\$ 182		262	\$ 116		140	\$ 98		96	\$ 54		121	\$ 58				
1968	1,288	510		1,508	580		723	353		697	323		1,120	455		713	355				
1969	1,449	516		1,446	533		658	332		653	314		1,088	447		621	328		925	361	
1970	1,321	479		1,416	544		570	304		640	309		1,053	436		593	317		1,351	533	
1971	1,349	487		1,455	544		568	306		599	295		1,123	456		652	332		1,297	519	
1972	1,207	451		1,388	526		511	284		589	287		936	431		658	334		1,272	513	
1973	1,130	432		1,410	531		599	384		587	304		889	532		588	385		1,340	700	
1974	1,109	590		1,363	680		512	448		301	263		932	606		499	437		1,190	927	
1975	1,072	790		1,220	889		470	422		371	314		865	717		507	461		1,269	948	
1976	984	755		1,084	839		397	428		397	384		885	878		347	371		1,347	1,119	
1977	1,060	928		663	643		390	462		441	439		911	915		242	438		1,298	1,272	
1978	977	977		559	679		260	406		515	528		778	1,104		243	524		1,313	1,510	
1979	1,113	1,252		693	841		194	339		475	630		921	1,102		281	580		1,334	1,796	
1980	922	1,245		676	992		390	367		309	780		866	1,350		643	822		1,334	1,774	
1981	948	1,335		788	1,195		377	435		258	1,125		860	1,796		482	997		1,240	2,198	
1982	1,089	1,913		811	1,648		355	598		206	1,204		860	2,066		494	1,351		1,150	2,482	
1983	1,154	2,221		938	2,157		288	591		249	1,224		902	2,036		456	1,268		1,215	2,535	
1984	1,066	2,206		842	2,087																
Year	DP-24			DP-25			DP-26			DP-27			DP-28			Totals			Average Power		
	Ohmar to Oleander			Orange to Ohmar			Oxalis to Orange			EHL Lat. 11 to Lat. 12			Oasis to Orient			Acre-Feet Recovered			Cost Per Acre-Foot		
	Acre-Feet Recovered	Cost		Acre-Feet Recovered	Cost		Acre-Feet Recovered	Cost		Acre-Feet Recovered	Cost		Acre-Feet Recovered	Cost		Acre-Feet Recovered	Cost				
May to Dec. 1967	-	-		-	-		-	-		-	-		-	-		736	287		\$ 0.43		
1968	-	-		-	-		-	-		-	-		-	-		2,374	1,018		0.42		
1969	-	-		-	-		-	-		-	-		-	-		6,210	2,582		0.42		
1970	-	-		-	-		-	-		-	-		-	-		6,682	2,794		0.41		
1971	406	143		-	-		-	-		-	-		-	-		7,417	3,073		0.41		
1972	1,854	653		1,361	627		3,309	1,120		2,731	1,012		-	-		10,049	4,165		0.39		
1973	1,795	636		1,489	648		3,714	1,825		3,195	1,548		2,369	1,063		15,830	6,228		0.51		
1974	1,850	884		1,109	603		3,368	2,362		3,046	2,097		3,094	1,822		18,712	9,498		0.71		
1975	1,460	1,124		1,300	995		3,126	2,387		3,062	2,271		3,296	2,092		17,994	12,760		0.76		
1976	1,388	1,168		1,370	1,195		3,047	2,665		2,947	2,566		3,244	2,412		17,792	13,569		0.88		
1977	1,760	1,388		1,210	1,388		3,704	2,665		3,039	2,863		3,255	2,633		17,304	15,170		0.96		
1978	1,833	1,569		1,322	1,544		3,777	3,475		3,014	2,863		3,449	3,383		17,971	17,266		1.16		
1979	1,639	1,827		1,146	1,780		3,332	3,777		2,883	2,469		3,499	3,923		17,623	20,401		1.35		
1980	1,625	2,138		1,113	2,061		3,357	4,469		2,883	3,836		3,321	3,923		17,116	23,171		1.37		
1981	1,456	1,915		1,249	2,139		3,235	4,339		3,021	4,040		3,148	3,923		17,560	23,979		1.80		
1982	1,523	2,346		1,188	2,741		3,460	5,966		2,947	5,213		3,148	4,956		17,383	31,334		2.12		
1983	1,478	2,666		1,287	3,137		3,373	6,788		2,794	5,691		3,052	5,928		17,142	36,289		2.06		
1984	1,440	2,690		1,120	3,092		3,280	5,539		3,280	5,539		2,669	5,807		16,807	34,614				

Mileage: .50 Mile - Total 6.00 Miles
Power costs calculated in Engineering Section

5. Automatic Controls

The Water Control Section and the Watermaster operate remote electronic monitoring and control devices at 22 locations, including the All-American Canal. The hydrographers and other field personnel can operate these facilities manually in case of power outages and emergencies. Automatic control and remote monitoring of operations will increase under the present District Plan as provisions for telemetry are built into every new or replacement structure.

6. Evaporation Ponds

Evaporation ponds have been constructed at 17 locations in the New and Alamo Rivers to reduce inflow to the Salton Sea. Through 1984, \$1.5 million has been expended on this program.

G. OPERATIONAL PROGRAMS

Operational Programs refer to changes in operational procedures that have been initiated to promote water conservation.

1. Radio Equipment

All water-operation personnel have radio equipment for rapid exchange of information. The District also has installed radio equipment in all the division offices (where water orders are received and processed) as well as in the operating headquarters. Effective communication between operating personnel (zanjeros, water clerks, and their supervisors) and farmers improves the efficiency of daily operations. It also provides instant communication among personnel during emergencies. Better communication permits greater operational flexibility in switching water deliveries from one farmer to another, thereby reducing operational spills. The Water Department currently has 11 base stations and 147 mobile radios.

2. Personnel Training

As operational methods are changed and structures built or modernized, the District has established a training program for all Water Department employees. New employees tour the District facilities to gain an overall view of the operations. Specialized training in water measurement and management is given to new zanjeros and hydrographers. Each division has monthly meetings to discuss operations, conservation, safety, etc. Daily on-the-job training is an integral part of the training program. As conditions in the field change, supervisors inform their personnel of new procedures and methods.

H. ADMINISTRATIVE PROGRAMS

Administrative options are available to public distributors of water. An example is the establishment of incremental water rates to encourage water conservation.

1. 13-Point Program

In July 1976, the District supplemented its existing water conservation efforts with a stringent 13-Point Program (Table IV.3). The overall goal of the 13-Point Program was to improve water use efficiency within the District and reduce inflow to the Salton Sea.

The achievement of these goals has been completed. Three reservoirs (Sheldon, Fudge, and Sperber) have been constructed. An accelerated program to reconstruct farm outlet (tailwater) boxes has been instituted. More zanjeros and hydrographers are being used. A tailwater assessment program is in progress to monitor tailwater and assess penalties for excessive discharges. Evaporation ponds have been constructed at 17 locations along the New and Alamo Rivers. In cooperation with the USBR, a study is in progress to determine seepage along the East Highline Canal. Drainage water is available on request. Lateral prioritization for the concrete-lining program has been assumed by the District. To determine actual water deliveries versus water ordered and billed, the District's computerized billing system is being modified. Radio equipment has been installed in water operation personnel vehicles, and the District's water conservationist works directly with farmers on irrigation management programs. Water Control personnel make off-schedule water deliveries after determining that there is excess water, contacting field personnel, and locating a second party willing to receive the excess water.

TABLE IV.3
IMPERIAL IRRIGATION DISTRICT 13-POINT PROGRAM
FOR WATER CONSERVATION

Point	Description	Targeted Water Loss Reduction
1	Construct water regulating reservoir on Westside Main Canal	Operational spills
2	Reconstruct farm outlet boxes, as required	Tailwater runoff
3	Assign adequate water regulating personnel to provide more efficient deliveries	Tailwater runoff and operational spills
4	Conduct daily inventory of surface field discharge and charge users who waste water an assessment for that day equal to three times the scheduled water rate	Tailwater runoff
5	Develop surface water evaporation ponds	Inflow to Salton Sea
6	Conduct preliminary studies for a regulating reservoir on Central Main Canal	Operational spills
7	Conduct study of the water recovery lines paralleling the East Highline and Westside Main Canals to recover seepage that is now going into the drainage system and the Salton Sea	Canal Seepage
8	Provide free drainage water to persons willing to pump and use it	Inflow to Salton Sea
9	Continue the concrete-lining program	Canal Seepage
10	Initiate a record of accrued water use by computerized billing	Tailwater Runoff
11	Install radio equipment in all water conservation-related vehicles to provide immediate communication	Tailwater runoff and operational spills
12	Initiate irrigation management services program	Tailwater runoff
13	Deliver water off-schedule when possible	Tailwater runoff

2. Water Conservation Advisory Board

The District Board of Directors recognized the need to continue and expand water conservation efforts and in 1979 appointed a Water Conservation Advisory Board made up primarily of District farmers. The purpose of the Advisory Board is to make recommendations to the District Board regarding the implementation of additional water conservation measures. Meetings of the Advisory Board were held on a regular basis, and resolutions were adopted by the Board, setting forth suggested additional water conservation measures. The recommendations presented by the Advisory Board were reviewed by the District Board and, in 1980, the District Board adopted a 21-Point Program intended to supplement the original 13-Point Water Conservation Program adopted in 1976.

The Advisory Board has remained active since its formation and continues to work with the District Board in order to obtain more efficient water use within the District.

3. 21-Point Program

The 21-Point Water Conservation Program recommended by the Water Conservation Advisory Board and adopted by the District Board is set forth as follows:

- (1) The District shall establish a penalty of \$100.00 for the unauthorized adjusting of delivery gates, which results in a change in the amount of water being delivered. Furthermore, whenever a water order is in the process of being pumped through a sprinkler or gated pipe system and the operator-user experiences a mechanical failure of the subject equipment, said operator-user shall be permitted to discontinue his water delivery for a period of not more than 3 hours. The free time permitted under this schedule shall be considered as separate instances, but in no event shall the combined hours so considered exceed 3 hours before a triple charge is to be assessed.
- (2) The concept of installing gate control devices of a standard design is recommended and supported, such devices to be installed on structures accommodating gates that are owned, operated and maintained, as well as regulated, under the jurisdiction of the District and its personnel.
- (3) Application of the assessment charge shall apply on the same basis to all types of irrigation, with the following exceptions:

- (a) The percentages of surface runoff allowed when water is being used to irrigate plowed or flat unseeded ground shall be 5 percent for the last day of said irrigation; no measurable waste shall be allowed for any previous days.
- (b) When water is being run in furrows to germinate crop seeds and establish a stand, no assessment charge shall be made unless one of the two consecutive measurements showing 15 percent or more runoff is made between 12:00 noon and 6:00 p.m.
- (4) In the event a water user is receiving more than his confirmed order, said surplus shall be subtracted from his surface runoff for the purpose of determining if his runoff is excessive.
- (5) In no event shall any water user be assessed unless his runoff is 15% or more of his running order irrespective of the quantity of water the user is receiving.
- (6) Any surface runoff measurement made within 4 hours after the District has reduced the quantity of water delivered shall apply to the order in effect before said change.
- (7) The application of an assessment charge based on waste measured after the delivery gate is closed shall apply on the same basis as when water was actually running. Any assessment made after the gate is closed shall be based on the order last running.
- (8) In no event shall the user pay more than triple the normal charge for water, except when he adjusts the delivery gate without permission.
- (9) All net proceeds from surface runoff assessment charges shall go into a special fund for conservation purposes other than the concrete lining of ditches.
- (10) All District personnel whose duties include checking of surface runoff will initial any waste assessment sheet issued.
- (11) Changes can be made for the last day of a run by notifying the District not later than 3:00 p.m. of the preceding day.
- (12) When a water user requests an adjustment in the quantity of water delivered not to exceed $2 \text{ ft}^3/\text{s}$, the District shall be obliged to honor the same if it is within the ability of the District's system to accommodate such a request and if the water user